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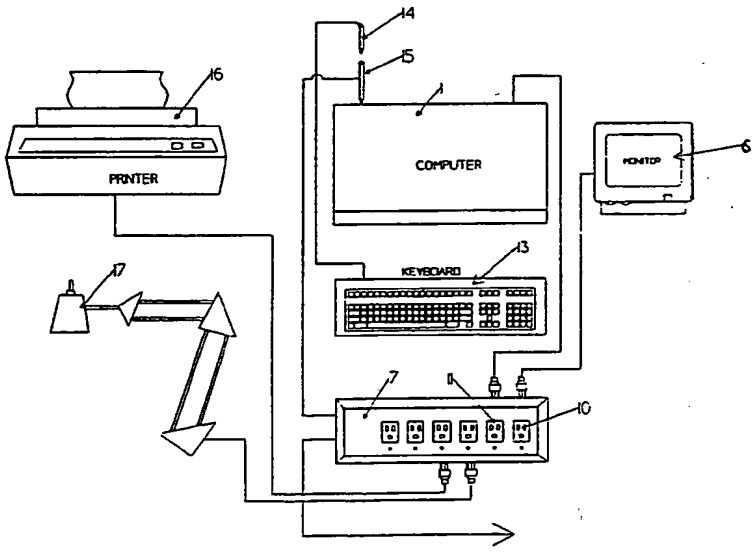
(54) Title: POWER MANAGEMENT SYSTEM



(57) Abstract

A power management system for use in association with desktop computers and like equipment powered from a mains supply, comprises: a monitor for monitoring Input/Output activity on the computer; a device for generating a time-out signal due to the absence of Input/Output activity during a predetermined period of time; a device for storing user-selectable criteria determining the response of the system to said time-out signal; a device for generating a data signal at an external interface port of the desktop computer based on said stored criteria and the presence of the time-out signal; and an external power supply device, comprising a power inlet for connection to the mains supply, a plurality of power outlets for supplying power to the desktop computer and associated peripheral equipment, controllable switches associated with each power outlet for selectively connecting and disconneting the power supply thereto in response to a control signal, an interface connectable to the external interface port for receiving said data signal therethrough, and a processor responsive to the data signal to generate the control signals for the controllable switches associated with the power outlets in accordance with the stored user-selectable criteria. The system can result in substantial energy savings due to the reduction in wasted energy caused by computers being left on while unattended.

POWER MANAGEMENT SYSTEM

This invention relates to a power management system for desktop computers and like equipment, such as computer terminals and periperals that are normally powered from the mains supply.

Although it has not previously been recognized as a major problem, computer-related equipment accounts for a substantial proportion of electricity consumption in large office buildings. Casual observation of many offices will reveal that computers and associated peripherals often remain switched on even though they are not in use. Typical daytime loads for desktop computers, their peripherals and other electronic office equipment have been estimated at about 10 - 20 w/m^2. Furthermore, electronic office equipment is expected to have the highest growth rate of all end-uses of electrical energy in the North American commercial sector. By 1995 there will be up to 65 million personal computers in business use in the United States alone, with estimates for office equipment electricity use for 1995 ranging from 25TWh. - 130 TWh., (1TWh. = 1 billion KWh.).

Although this growth in electrical power consumption is well documented, what has not been previously recognized is how much of the total power consumption of EDP equipment and peripherals is wasted.

Not only does wasted energy result directly from the consumption of the computer equipment, it also result from increased load on building cooling systems required to dissipate the heat generated by unused computers and peripherals. Although building cooling load will be climate dependent, and in some cases the

An object of the present invention is to provide a power management system that results in significant power savings for PC users.

According to as first aspect of the invention there is provided a power management system for use in association with desktop computers and like equipment powered from a mains supply, comprising: monitoring means for monitoring Input/Output activity on said computer; means for generating a time-out signal due to the absence of Input/Output activity during a predetermined period of time; means for storing user-selectable criteria determining the response of the system to said time-out signal; means for generating a data signal at an external interface port of the desktop computer based on said stored criteria and the presence of said time-out signal; and external power supply means, comprising a power inlet for connection to the mains supply, a plurality power outlets for supplying power to the desktop computer and associated peripheral equipment, controllable switch means associated with each said power outlet for selectively connecting and disconnecting the power supply thereto in response to a control signal, interface means connectable to said external interface port for receiving said data signal therethrough, and processor means responsive to said data signal to generate the control signals for the controllable switch means associated with said power outlets in accordance with said stored user-selectable criteria.

The power management system in accordance with the invention is a retro-fit product for use with a.c. grid powered computers and peripherals, which more closely tailors the power on time of these computers and peripherals to the user activity of these devices

The user can also set the system to inhibit shut down if an application is still active. Alternately, the system can be set to transfer the contents of the RAM to disk prior to shut down so that when the computer is restarted it automatically reverts to the state it was in prior to shut down.

The invention also provides retrofittable power saving apparatus for use with desktop computers and like equipment powered from a mains supply, comprising a power inlet for connection to the mains supply, a plurality power outlets for supplying power to a desktop computer and associated peripheral equipment, controllable switch means associated with each said power outlet for selectively connecting and disconnecting the power supply thereto in response to a control signal, interface means connectable to an external interface port in said desktop computer for receiving distinctive data through said port controlling the state of said apparatus, and processor means responsive to said data to generate the appropriate control signals for said switch means.

The apparatus as claimed can further comprise means for monitoring the phase angle of said power outlets, and means for controlling said switch means to manage and reduce the departure from unity of the power factor of the individually connected EDP devices.

The apparatus can also include an infrared occupancy sensor for detecting the presence of an individual at the computer station and generating an inhibit signal in the presence thereof.

Figure 9 is a flow chart of the control program for the microcomputer in the power bar.

In order to evaluate the system, the power consumption and electrical operating characteristics of several hundred typical desktop computers and peripherals were measured on-site using a BMI 3060 Power Profiler (198 computers, 112 monitors, 41 printers, 6 plotting devices, and 7 external hard disk drives). The measured plug load for these devices was 3.4 W/m^2 (0.3 W/ft^2), which although lower than the 14.0 W/m^2 (1.3 W/ft^2) load calculated from nameplate ratings, represents a major part of the load of an office building.

Prior to the research leading to the invention, no direct data were available on desktop computer use profiles, or the portion of time that a machine is used when it is turned on. Energy modelers have relied on anecdotal evidence, metered plug loads from which office equipment and desktop computer loads are extracted, or indirect estimates of desktop computer use patterns based on time-share mini and mainframe computer system logon records.

The actual desktop computer use patterns on 94 machines at three Canadian Federal Government sites located in the Ottawa area were monitored using custom computer activity monitoring software.

Referring to Figure 1, the top curve shows the mean number of minutes in every hour the computers were switched on. The bottom curve shows the mean number of minutes in every hour there were keystrokes (or keystrokes/mouse clicks for Macintosh computers): note

peak electrical demand returned to pre-sticker levels, at the end of the 8 week period.

A power management system in accordance with invention was installed on sixteen computers at another of the three monitoring sites, and collected computer use data for another eight weeks. As shown in Figure 3 shows the mean number of hours per computer per week before (solid line) and after (dashed line) the installation of the power management system. After installation, mean computer energy consumption fell by 63 percent, with a mean reduction in peak electrical power demand of 41 percent. Video display unit (VDU) mean energy consumption was reduced by 82 percent.

The predicted savings due to the power management system at this site, with a 60 minute keyboard/mouse inactivity switch off were: a 71 percent reduction in electrical energy consumption, and a 44 percent reduction in mean peak demand. The measured savings are remarkably close to the predictions. The main reason reductions are slightly lower than predicted is that users could opt for the system not to switch off their computer if an application program was open. This option did not affect the switching of VDUs, and the observed reduction in on-time of independently switchable VDUs of 82 percent is almost identical to the prediction of on-time reduction after 15 minutes of keyboard/mouse inactivity of 83 percent.

Figure 4 shows a computer 1, which can, for example be an IBM PC or Macintosh computer, an associated keyboard 13, monitor 6, power bar 7, printer 16, and desk lamp 17. The computer 1, printer 16, lamp 17, and monitor 6 are all plugged into respective, independently switchable outlets 10, 11 on the power

Although the majority of data signals originate from the keyboard 13 and flow into the keyboard interface 12, it is a little known fact that the keyboard interface 12 is bi-directional and can accept outgoing data bytes. For example, the "Num-Lock" status of the keyboard can be set through software on the computer, and this is achieved by transmitting an appropriate eight bit signal byte through the keyboard interface 12 to the keyboard 13.

In the present embodiment, an adapter interface 15 is inserted between the keyboard interface 12 and the keyboard connector 14. Under normal operating conditions, adapter 15 is transparent to the computer, and keyboard signals pass directly through the adapter without interception. Unlike communications over the serial or parallel ports, this arrangement does not use system resources.

However, the adapter interface 15 is also connected through lines 20 to power bar 7, which contains a microprocessor 21 with control oscillator 22 and TRIAC control devices 23 connected to the power outlets 10, 11. The connector 15 provides a high impedance receiver which is constantly "listening to or receiving" the data transmissions from the computer.

The data signals are in the form single eight bit byte data commands from the computer to the keyboard. The choice of data byte is such that the keyboard does not recognize the byte and therefore disregards it. The power bar 7 responds to the "invalid keyboard" codes by acting upon them from rules stored within the power bar 7's own internal microcomputer.

computer activity. This may be the exchange of data between a server computer and slave computer on a LAN system.

The change of state over a period of time would indicate to the power bar 7 TSR that a human has interacted with the computer indicating activity or that another machine has interacted with the computer also indicating activity. For example, monitoring serial ports will inhibit shut-down if the computer is communicating with a modem.

Provided that activity is present over a preset period of time, the power bar 7 TSR will remain inactive. Should the user stop interacting with the computer, (no activity), the TSR program will compare the elapsed time of inactivity with a set of user programmed criteria concerning the action to be taken when inactivity reaches a time programmed into the rules.

When a time-out occurs, (inactivity time = inactivity time from rules. i.e. time-out), the TSR sends a command to the power bar 7 to turn off the device for which the rule matches. By way of example, a user may state that the printer attached to the power bar 7 outlet number three is to be turned off when inactivity time with the computer = five minutes.

The TSR can be called by the user, for example, by activating a hot key, and the criteria for power management entered. Desirably this is done using a graphical user interface, (GUI) with mouth activated control buttons to permit entry of the desired criteria. For example, the user may wish to set the predetermined time delay before a time out occurs, and

f) As long as the computer is being accessed by the selected input/output device(s), the TSR will not communicate with the power bar 7 unless a manual outlet turn on/off command is called from the user menu by hot-key or pull down.

g) Should the user of the computer leave the computer on and not operate the computer, the TSR will start counting the number of minutes since the activity on the selected I/O port. When the time since the last activity equals the time-out period selected for a specified peripheral, the TSR sends a "turn off" signal to the power bar 7 over the keyboard communications link to turn off that peripheral device.

h) This will repeat until the last timer value, (the longest, also associated with the computer), is reached. When the time out period is reached for the computer, the TSR sends the turn off command for port 0. The computer will now be turned off by The power bar 7.

Figures 6a - 6c show snapshots of a typical GUI control screen, and it will be seen how the user can select power management criteria according to his or her particular preference.

During operation of the computer, the TSR runs in the background continuously monitoring the status of keyboard buffer 30. If no activity occurs during the preset time, for example, thirty minutes, the TSR causes a unique data signal to be transmitted through the keyboard interface 12. This is recognized by microprocessor 21, which acts upon the data signal to control the TRIAC with the data carried thereby. For example, if the user has determined that power to all

c) The TSR sends the "computer off" command to the computer keyboard interface buffer, which is in turn sent over the keyboard interface by the Peripheral Interface Adapter integrated circuit.

d) The power bar 7 turns off the power outlet number 10, (computer is plugged into this outlet).

e) The power bar 7 supplies power to the computer's keyboard through a blocking diode 35, which allows the power bar 7's internal power supply to keep the computer's keyboard active without supplying power to the computer.

f) When the user wishes to use the computer, pressing any key on the computer's keyboard will cause a data signal to be sent to the computer and to the power bar 7 through the interface cable.

g) The computer is turned off, and the computer does not receive the data signal.

h) The power bar 7's internal microcomputer receives the data signal from the computer's keyboard. Upon receipt of this data signal, the power bar's microcomputer 21 activates the appropriate control triac which in turn applies power to the computer.

i) The computer will perform its boot sequence and re-loads the power bar 7 TSR which will start performing its inactivity monitoring and comparison to the previously defined rules.

j) The user application program(s) may now be accessed.

interfaces, and any other interface communicating with external devices.

Referring to Figure 7, the robust moulded plastic casing 50 support outlets 10, 11 and circuit board 51 mounting control circuitry 52 and triacs 53 forming part of the triac control circuits associated with each power outlet. An LED 54 for each outlet indicates the status of its associated outlet.

The power bar 7 is designed to allow a non-technical person to connect the power bar 7 to their own computer system and associated peripherals. The chassis is designed to look similar to a standard power bar. The power bar 7 is constructed on a single, double sided printed circuit board which houses all of the necessary sub systems, including, a 120 volt a.c. input from the building power mains, low voltage power supply to drive the power bar 7 logic and supply necessary power to the user's keyboard when the computer is turned off, a keyboard strobe and power supply interface with serial bi-directional communications interface, micro-coded logic containing operational parameters for program control of the power bar 7, six three conductor power outlets, switching triacs for the individual control of each outlet, snubber networks for EMI and electrical surge suppression, and a circuit for controlling the power factor of controlled electrical loads by phase angle control of switching triacs.

Physically, the power bar 7 resembles a standard power bar assembly, having six outlets. Each outlet has a snubber protected switching triac which under control of a custom programmed microcontroller integrated circuit, will allow the control of each

The logic power supply converts the 120 volt mains supply to the necessary voltages required to operate The power bar's internal microcomputer. It also generates the 5 volt power supply required to operate the computer keyboard when the computer is turned off.

Switching power, (the a.c. mains) are routed to the 6 switched outlets. Neutral and Earth conductors are run in parallel to the six outlets and are not switched. Line one from the a.c. mains is run in a BUS to six triac devices, capable of turning line one on or off to the outlet associated with that particular triac. When a given triac is turned on by a signal from the microcomputer device internal to the power bar 7, Line one from the a.c. mains is connected to the outlet associated with the triac. The peripheral device attached to that outlet is therefore turned on.

Internal to the microcomputer 21, contained within the power bar 7, is a program which runs at all times that the power bar 7 is connected to the a.c. mains. This program is designed to do the following:

1) Receive serial data from the user microcomputer over the keyboard interface which is controlled by the control program.

2) Send serial data to the user microcomputer as directed by the control program.

3) Monitor the operation of the user's keyboard.

4) Send the necessary control signals to the six switching triacs.

This strobe is monitored by the power bar 7 and is assumed to be the "command" for the power bar 7 to turn on outlet #1, (which turns on the computer).

Control of the power bar 7 is now transferred to the control program, once the computer runs its initialization programs and boots the control program.

The power bar 7 can also include a remote power-up facility, enabling it to be activated by telephone. For this purpose the power bar 7 includes a standard telephone jack 40 (Figure 5) through which it is connected to the public switched telephone network. The line detector 41 detects the presence of an incoming call causing the power bar to switch on the some or all of the outlets 10,11 and maintain them on while the line is in use. Which outlets are switched on by remote control can be set in advance through the set-up program. For example, it might be decided that there is no need to activate the printer when the computer is being accessed remotely. The power bar 7 also remains on for a predetermined time after the line has been dropped. This enables a remote user to access the computer by modem without leaving the computer on continuously and without interfering with the power management functions of the system. If a user leaves his desk without switching off the computer, the power-down sequence will be automatically be initiated after the preset period of time. If the user subsequently wishes, for example, to extract data remotely, he can do so by telephoning in to activate, and after allowing a suitable period of time for the computer to complete its power-up sequence, initiate modem file transfer.

3. A power management system as claimed in claim 2, wherein said monitoring means monitors the keyboard buffer.

4. A power management system as claimed in claim 2, wherein said monitoring means monitors the mouse buffer.

5. A power management system as claimed in claim 2, wherein said monitoring means monitors the video buffer.

6. A power management system as claimed in claim 2, wherein said monitoring means monitors the serial port buffer.

7. A power management system as claimed in claim 2, wherein said monitoring means monitors the parallel port buffer.

8. A power management system as claimed in claim 2, wherein said monitoring means monitors the LAN adapter buffer.

9. A power management system as claimed in claim 1, wherein said user-selectable criteria include the duration of inactivity required to generate a time-out and the affect on the respective power outlets upon the occurrence of a time-out.

10. A power management system as claimed in claim 1, wherein said user-selectable criteria include the manual control of the power outlets through the computer.

a mains supply, comprising a power inlet for connection to the mains supply, a plurality power outlets for supplying power to a desktop computer and associated peripheral equipment, controllable switch means associated with each said power outlet for selectively connecting and disconnecting the power supply thereto in response to a control signal, interface means connectable to an external interface port in said desktop computer for receiving distinctive data signals through said port controlling the state of said apparatus, and processor means responsive to said data signals to generate the appropriate control signals for said switch means.

17. Retrofittable power management apparatus as claimed in claim 16, wherein said external interface port in the computer is the keyboard interface port, and said interface means is adapted to be connected between the keyboard interface port and the keyboard, said processor means being responsive to said distinctive data signals to generate appropriate control signals for said switch means.

18. Retrofittable power management apparatus as claimed in claim 16, further comprising means for monitoring the phase angle of said power outlets, and means for controlling said switch means to reduce the departure from unity of the power factor of the apparatus.

19. Retrofittable power management apparatus as claimed in claim 16, further comprising an infrared occupancy sensor for detecting the presence of an individual at the computer station and generating an inhibit signal in the presence thereof.

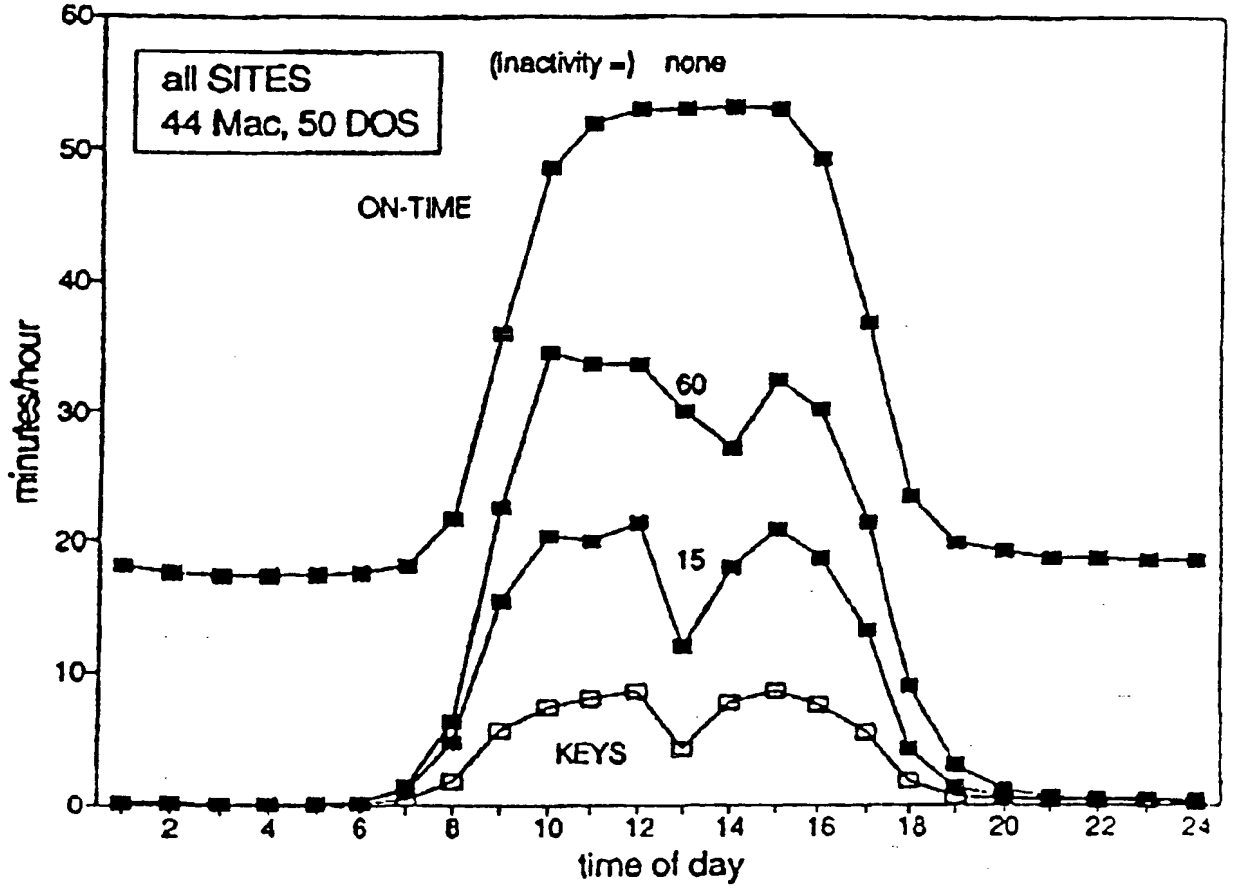


Figure 1

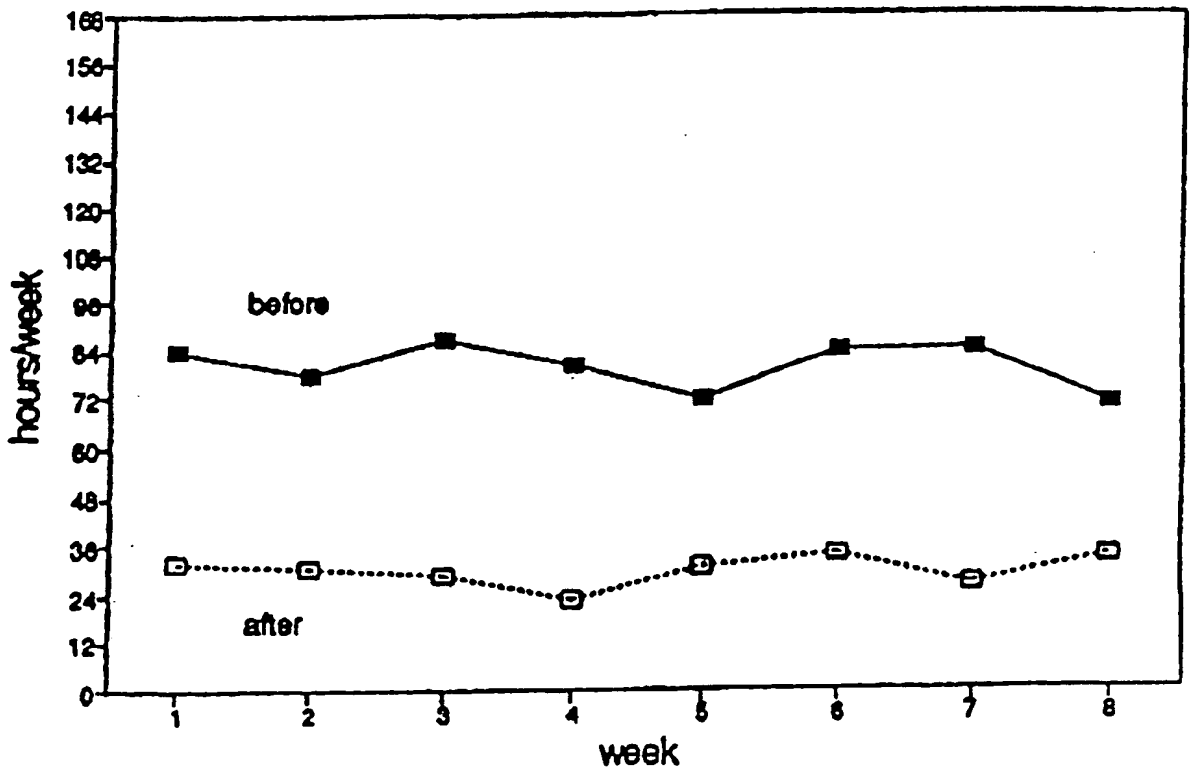


Figure 3

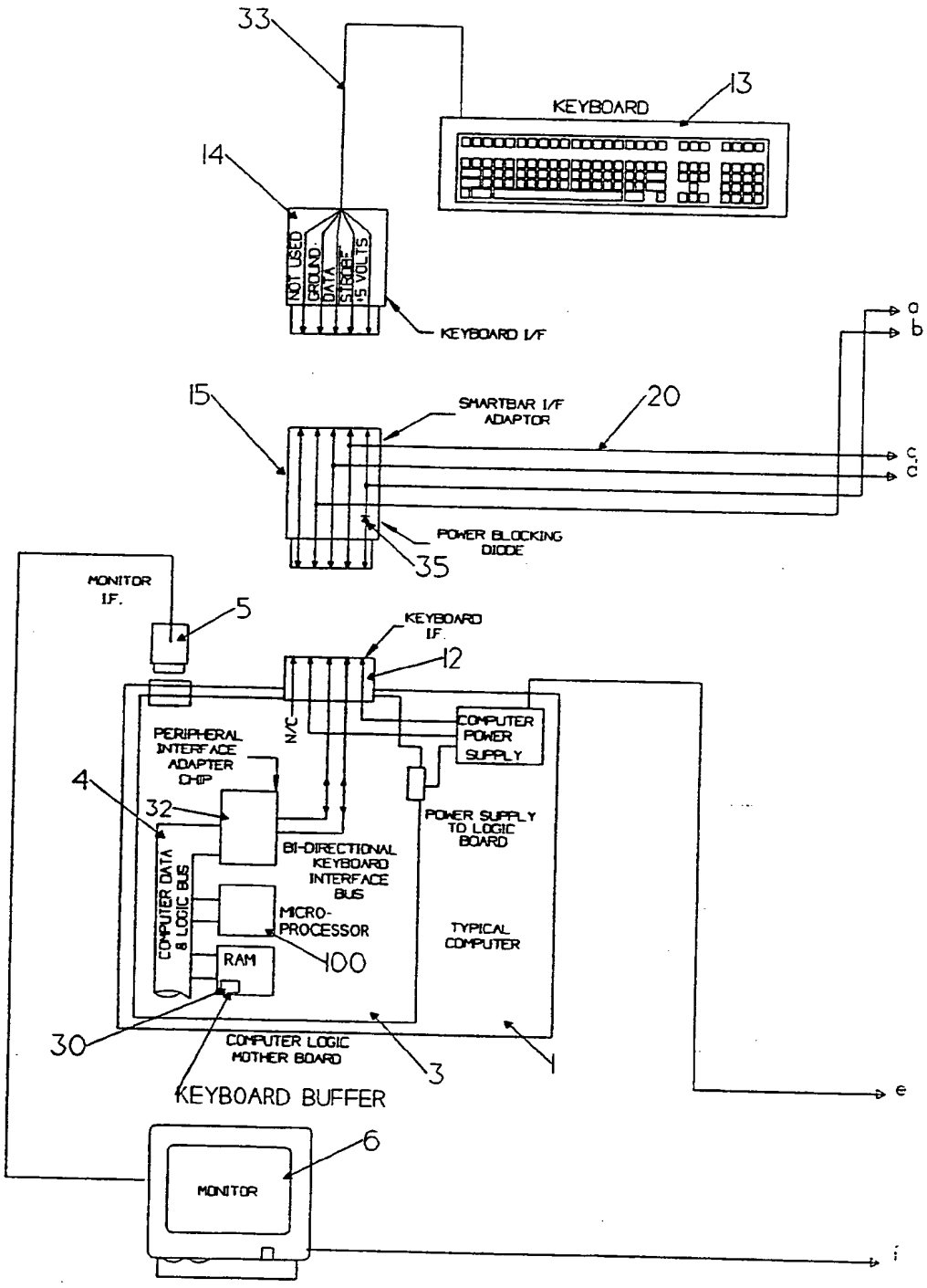


FIGURE 5a

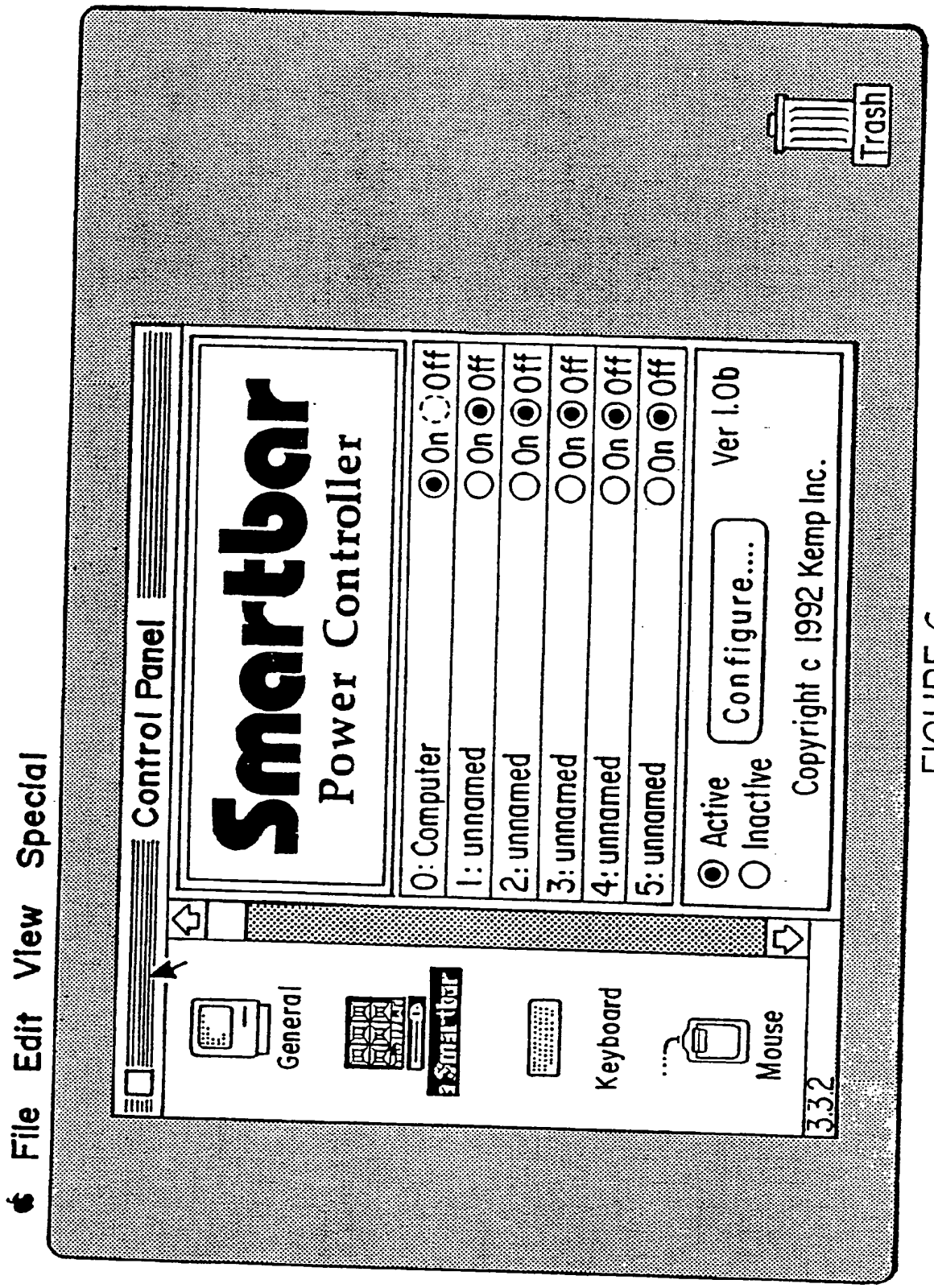


FIGURE 6a

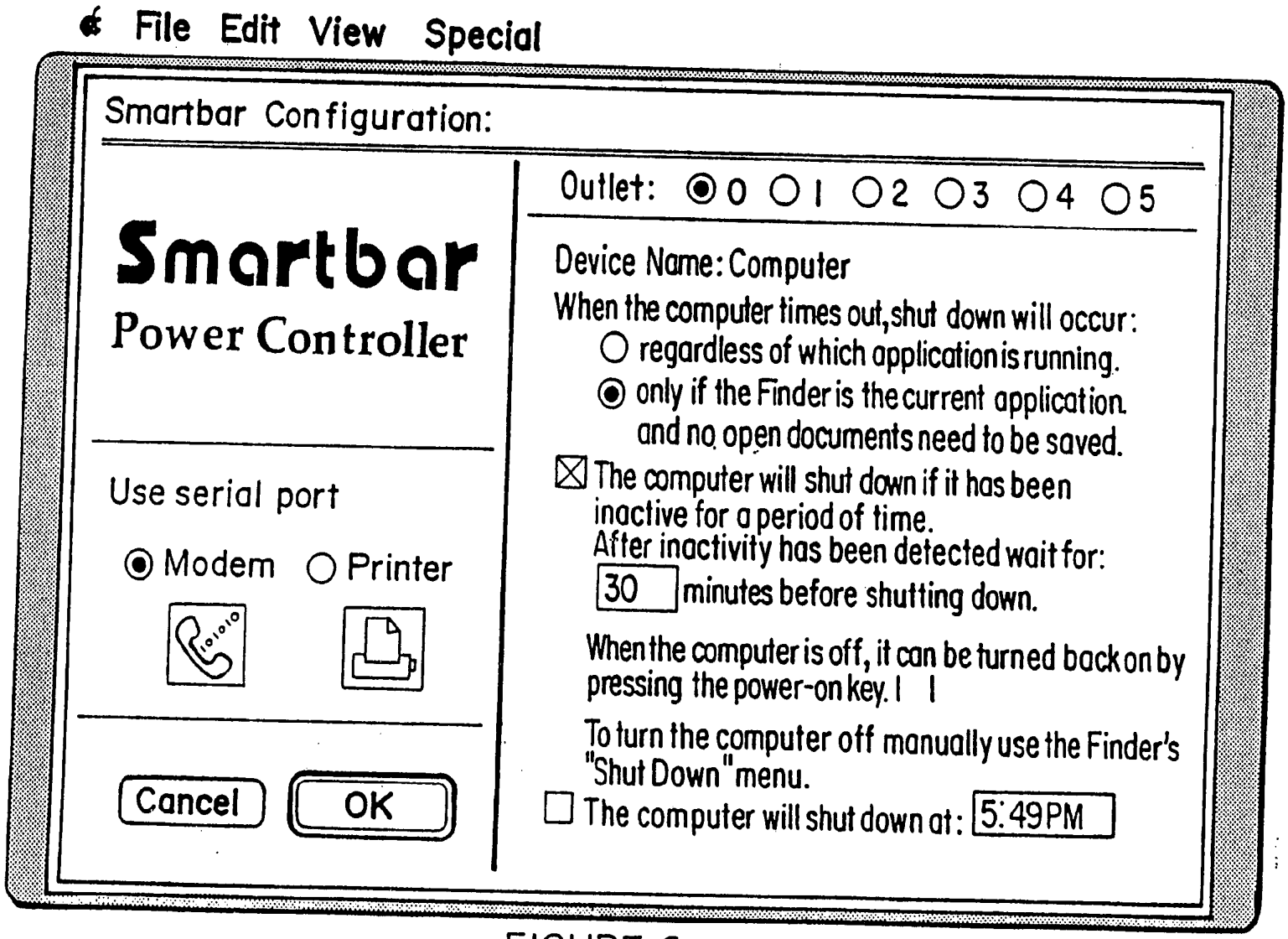
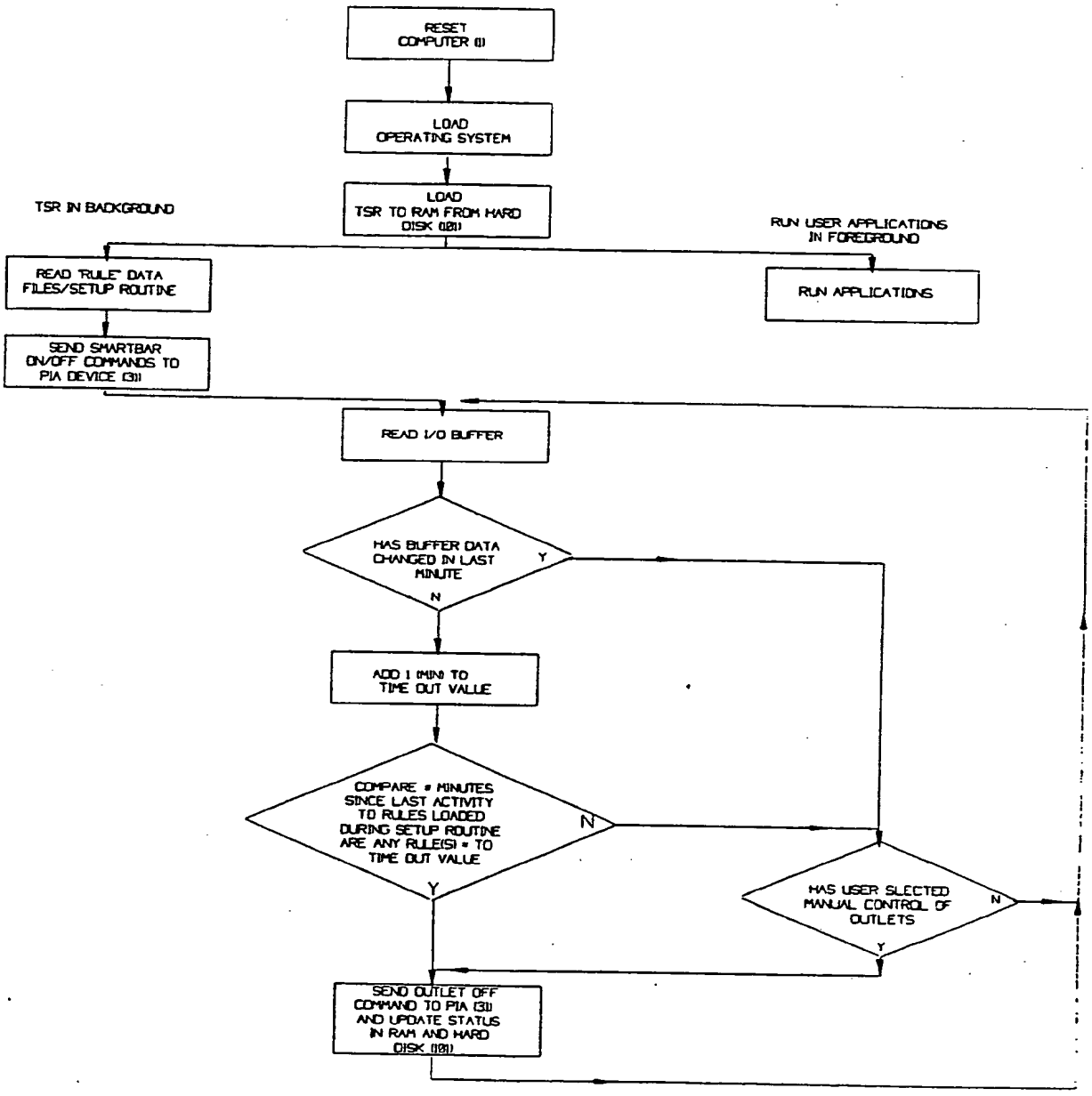


FIGURE 6c



TSR CONTROL PROGRAM

FIGURE 8

INTERNATIONAL SEARCH REPOI

International Application No PCT/CA 92/00441

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G06F1/32; G06F1/26

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G06F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	IBM TECHNICAL DISCLOSURE BULLETIN. vol. 33, no. 11, April 1991, NEW YORK US pages 460 - 461 , XP110473 'Programmable power supply unit' see the whole document	1-3,9, 12,13, 16,20
Y	HEWLETT-PACKARD JOURNAL vol. 37, no. 7, July 1986, AMSTELVEEN NL pages 4 - 13 JOHN T. EATON 'Design of HP's Portable Computer Family' see page 10, left column, line 24 - line 36 see page 10, right column, line 40 - page 11, left column, line 6 see page 11, right column, line 34 - line 40	1-3,9, 12,13, 16,20

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
18 JANUARY 1993	27. 01. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	LA GIOIA C.

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

CA 9200441
SA 64993

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A-4014683	21-11-91	None	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82